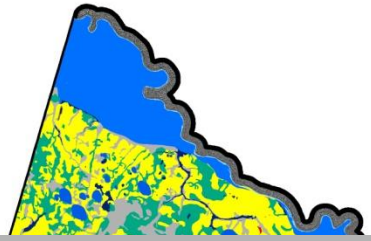


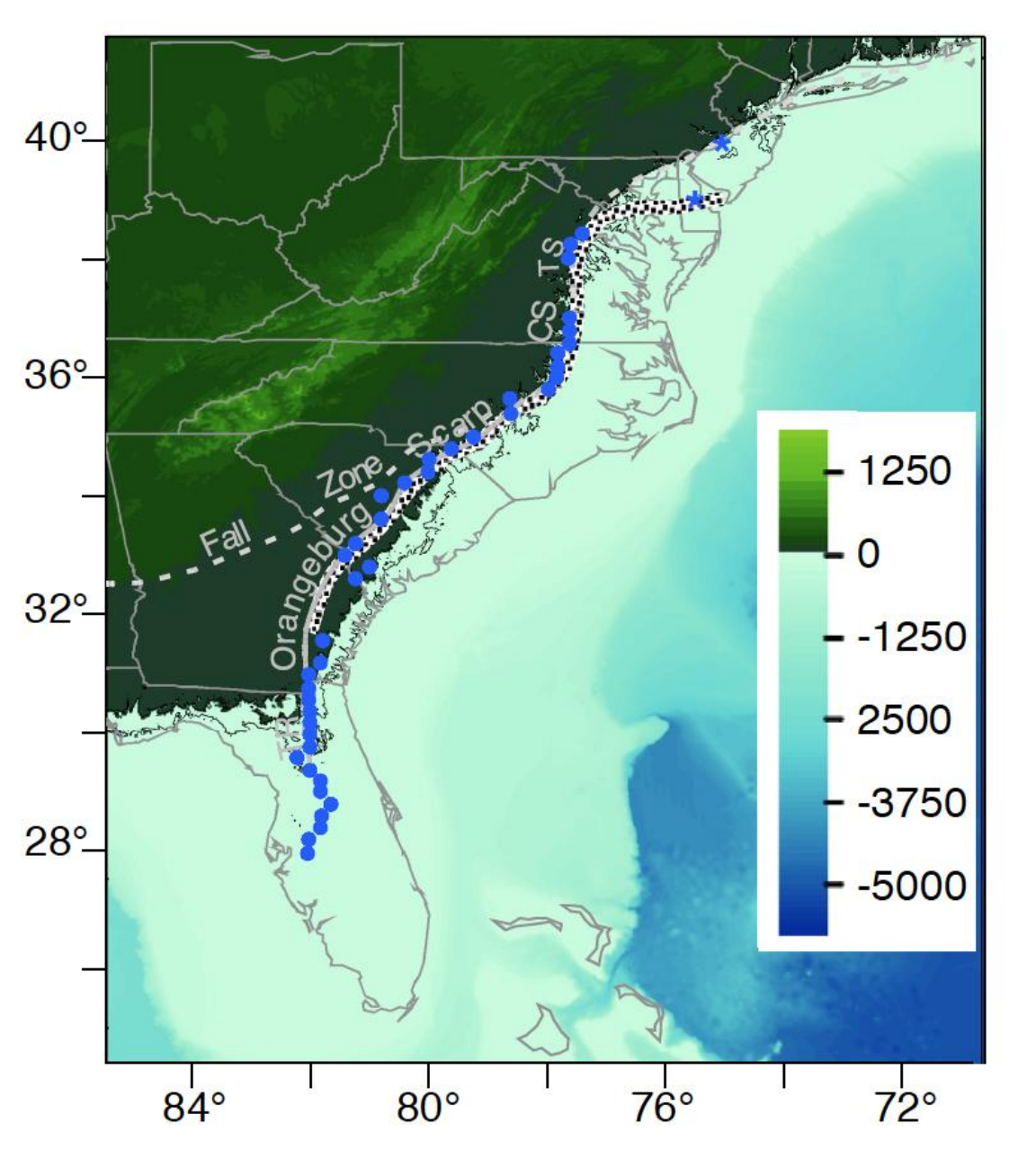
- **Climatic/Geologic, and Euro-American Settlement Influence on FM Ecological Systems**

- **1st Approximation Ecological Systems Mapping**

- **Modeling Ecological Systems in the Southeastern U.S.**

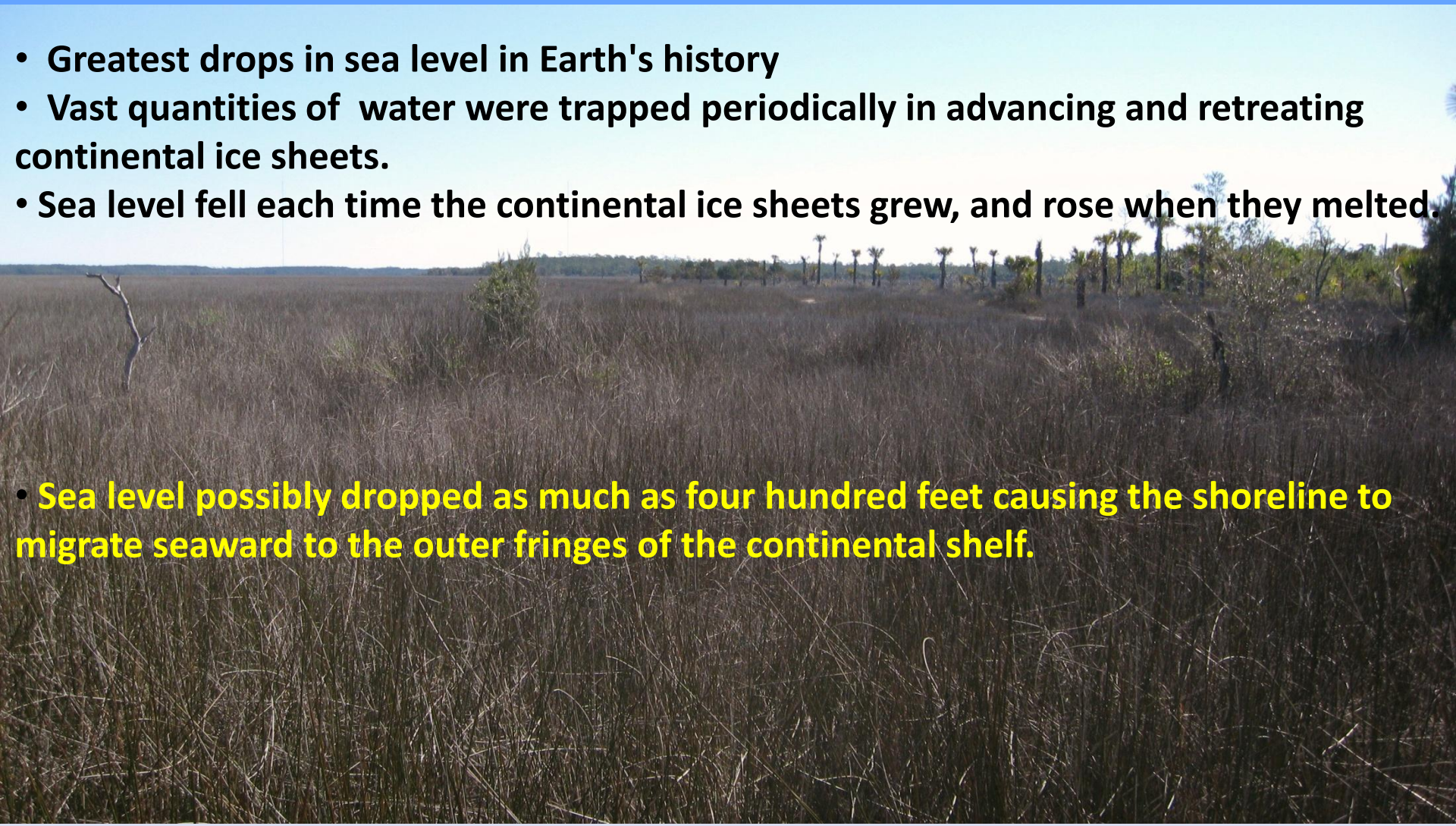
- **Modeling Ecological Systems on the Francis Marion National Forest**

Ecological Systems on the Francis Marion NF

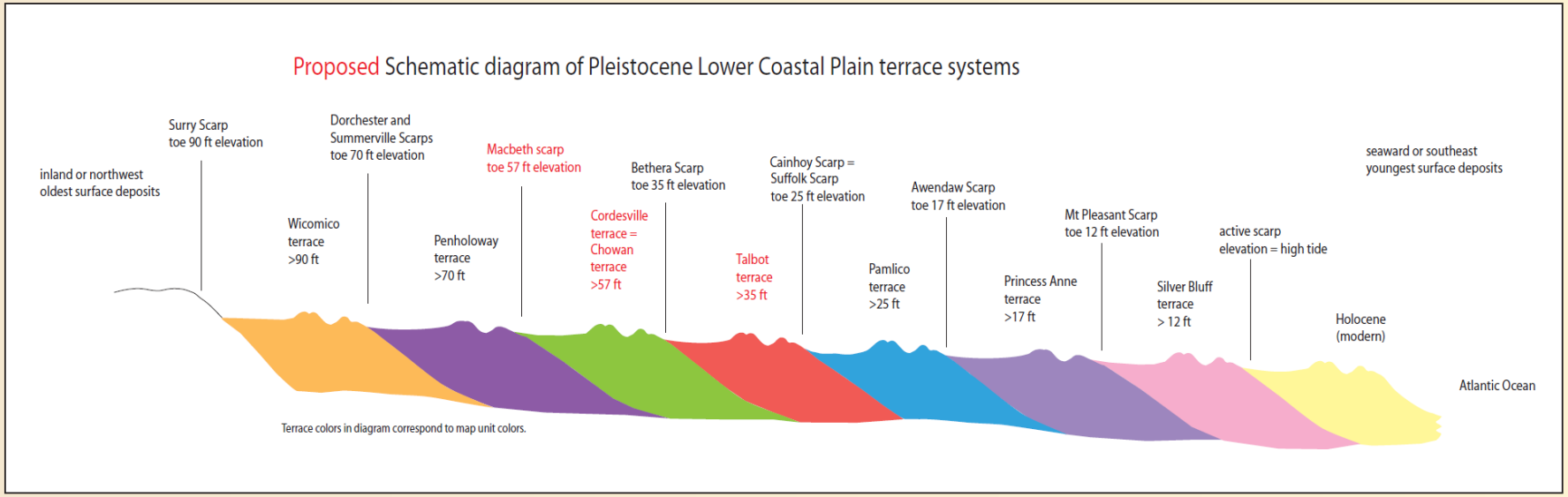


The East Coast shoreline as it appeared 3 million years ago during the middle Pliocene, ~3.5-2.5 Ma, a period of global warmth preceding the growth of major Northern Hemisphere ice sheets. The shoreline has been adjusted 82 feet relative to today. graphic: David Rowley/Science Express

- **Pleistocene Epoch (~2 million and 10,000 years before present)**



- **Greatest drops in sea level in Earth's history**
- **Vast quantities of water were trapped periodically in advancing and retreating continental ice sheets.**
- **Sea level fell each time the continental ice sheets grew, and rose when they melted.**
- **Sea level possibly dropped as much as four hundred feet causing the shoreline to migrate seaward to the outer fringes of the continental shelf.**
- **During low-stands in sea level, rivers incised into their flood plains, dumping their sediment load into deep water canyons carved by submarine erosion into the edge of the continental shelf.**



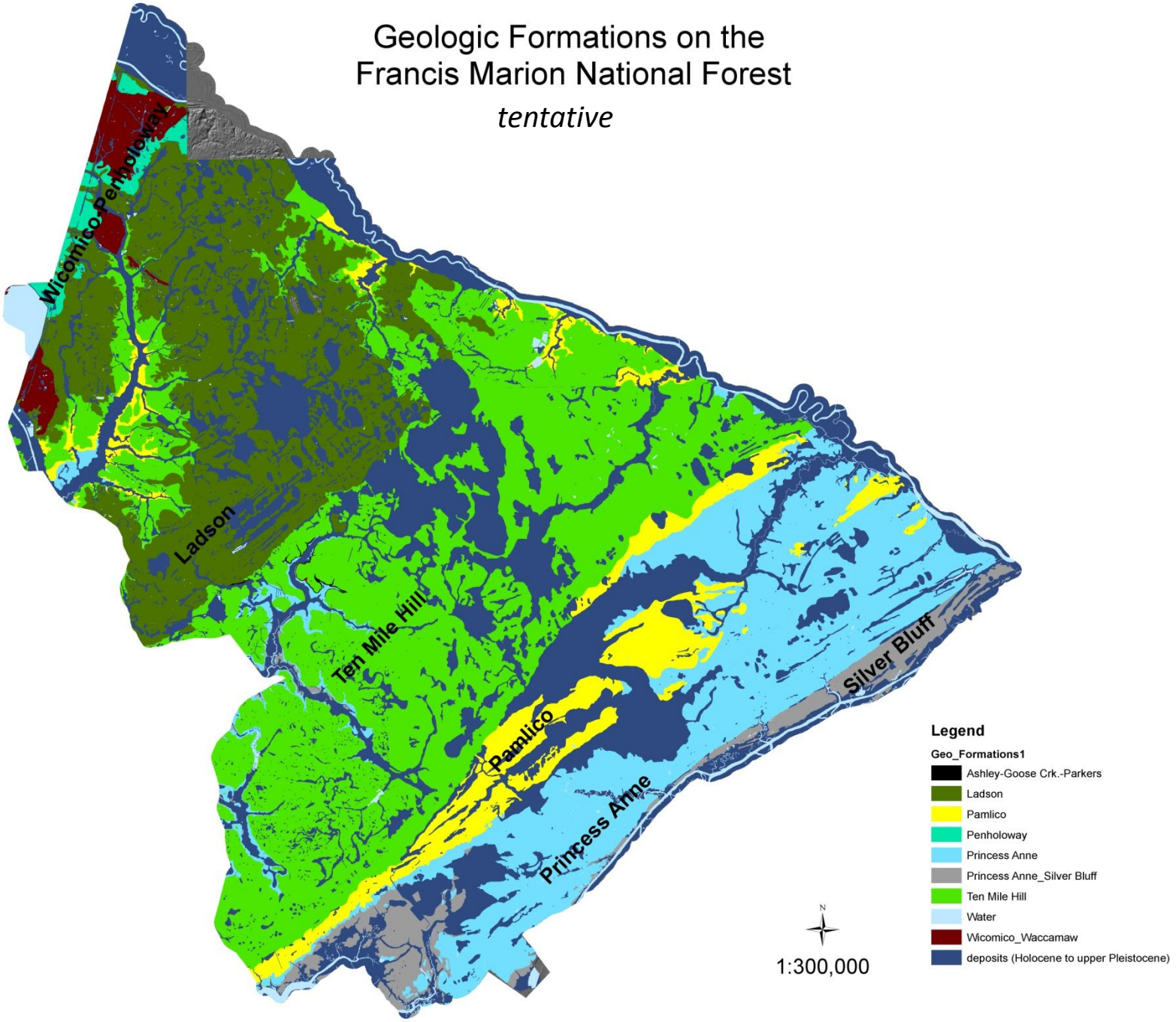
Terraces are sequentially younger at lower elevations →

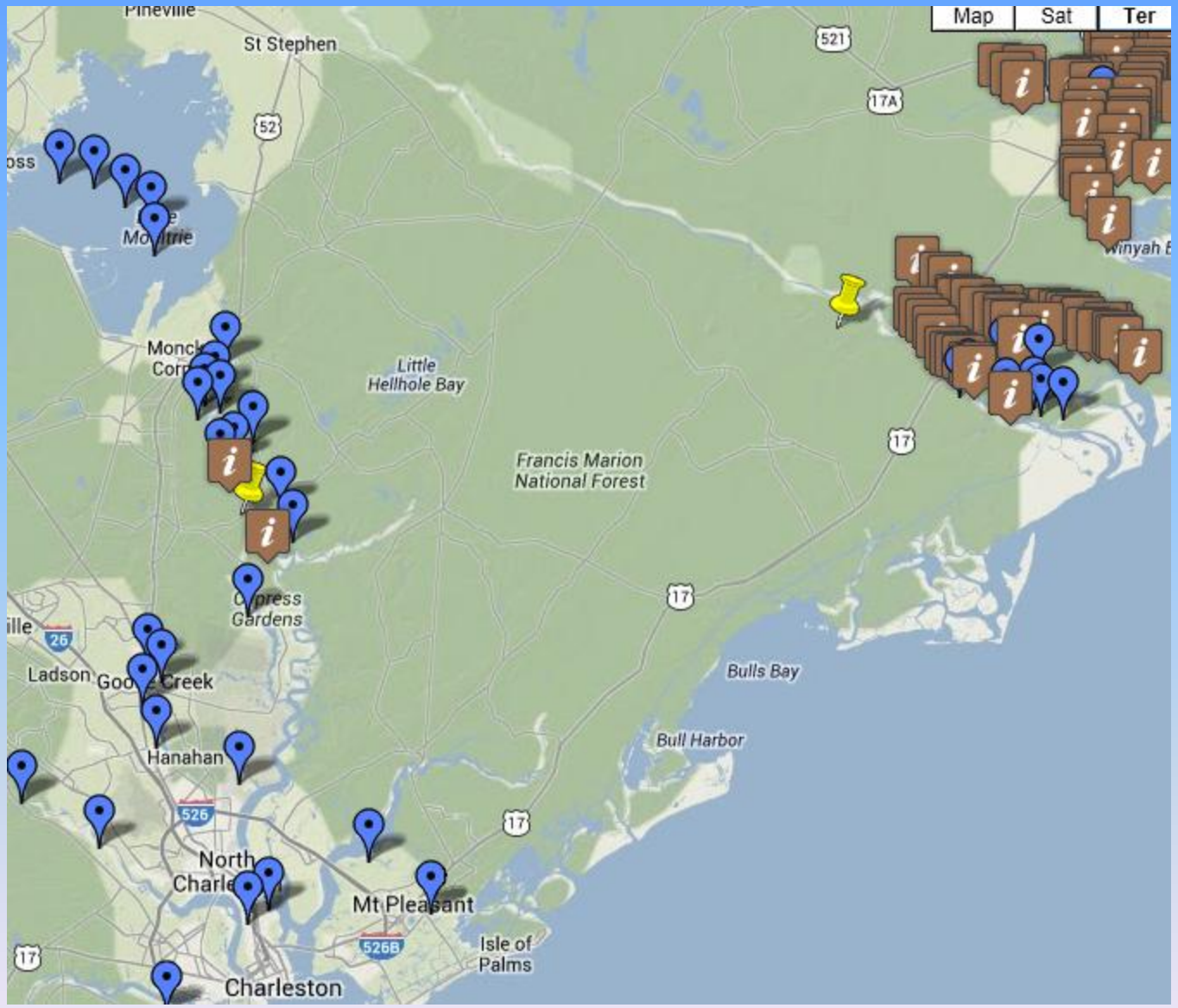
Multiple terraces in South Carolina (two Pliocene, seven Pleistocene) show that, since the mid-Pliocene, highstands of ocean level are trending toward lower levels, or southeastern North America is being uplifted, or some combination of both factors is at play.

Graphic from:
Ralph H. Willoughby and W.R. Doar, III
2006 South Carolina Department of Natural Resources
Geological Survey

Geologic Formations on the Francis Marion National Forest

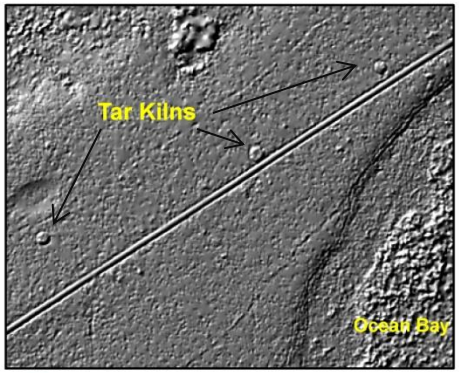
tentative





Rice plantations on or near the Francis Marion NF

Roads, Dikes, Ditches, and Tar Kilns on the Francis Marion NF



1:200,000

Legend

- tarkiln
- FMroads_modelarea
- someDitches
- mostDikes

- Field data (Simon-Hayden, CVS, FM Rare Communities)

- Digitized distinct types from the 5 ft. LiDAR generated hillshade:
  Salt and Brackish Tidal Marsh, Maritime Forest, Large River Floodplain Forest,
  Small Blackwater River Floodplain Forest and *Blackwater Stream Floodplain Forest*
  Tidal Wooded Swamp, Carolina Bay Savanna, Depression Pondshore, Depression sinks phase
  Peatland Pocosin and Canebrake, Streamhead Seepage Swamp, Pocosin and Baygall
  Dry and Dry-Mesic Oak Forest, Mesic Slope Forest, Nonriverine Basin Swamp

- Used the NRCS soil coverage to map the location of:
  Upland Longleaf Pine Woodland , Wet Pine Savanna and Flatwoods
  Nonriverine Swamp and Wet Hardwood Forest.

Salt and Brackish Tidal Marsh with Maritime Forest fringe, Guerin Creek

Ecological Systems 1st approximation mapping process

1st Approximation

(from most extensive to least extensive)

Southern Atlantic Coastal Plain Wet Pine Savanna and Flatwoods

Southern Atlantic Coastal Plain Nonrivering Swamp and Wet Hardwood Forest

Atlantic Coastal Plain Upland Longleaf Pine Woodland

85% of FM

Atlantic Coastal Plain Blackwater Stream Floodplain Forest

Atlantic Coastal Plain Small Blackwater River Floodplain Forest

Southern Atlantic Coastal Plain Large River Floodplain Forest

Southern Atlantic Coastal Plain Tidal Wooded Swamp

Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh

Atlantic Coastal Plain Carolina Bay Cypress Wetland

Southern Atlantic Coastal Plain Nonriverine Basin Swamp

Atlantic Coastal Plain Peatland Pocosin and Canebrake

Southern Atlantic Coastal Plain Depression Ponds

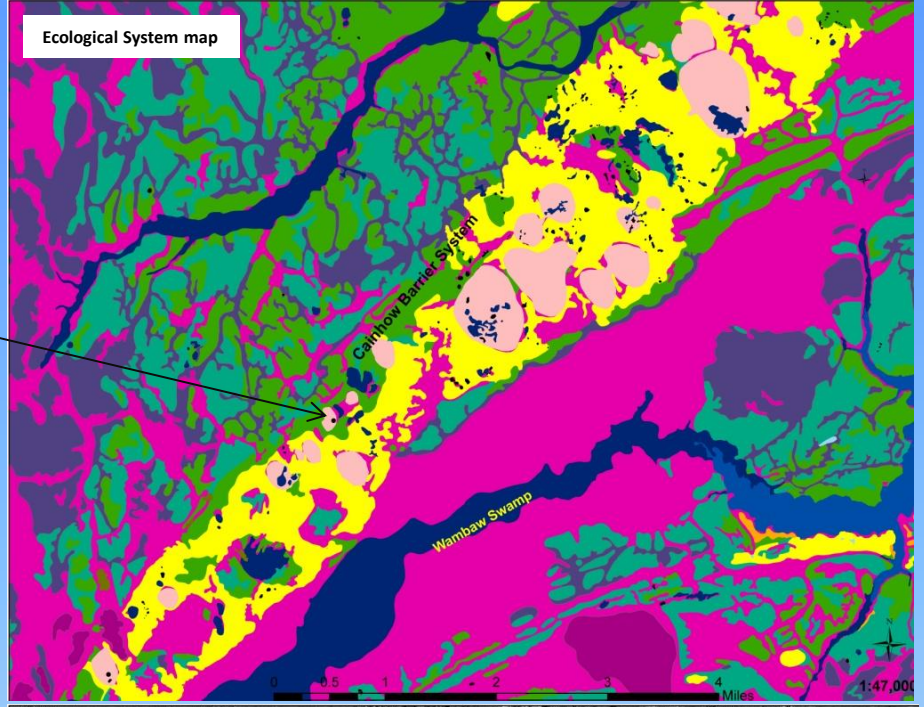
Southern Atlantic Coastal Plain Dry nd Dry-Mesic Oak Forest

Central Atlantic Coastal Plain Maritime Forest

Southern Coastal Plain Mesic Slope Forest

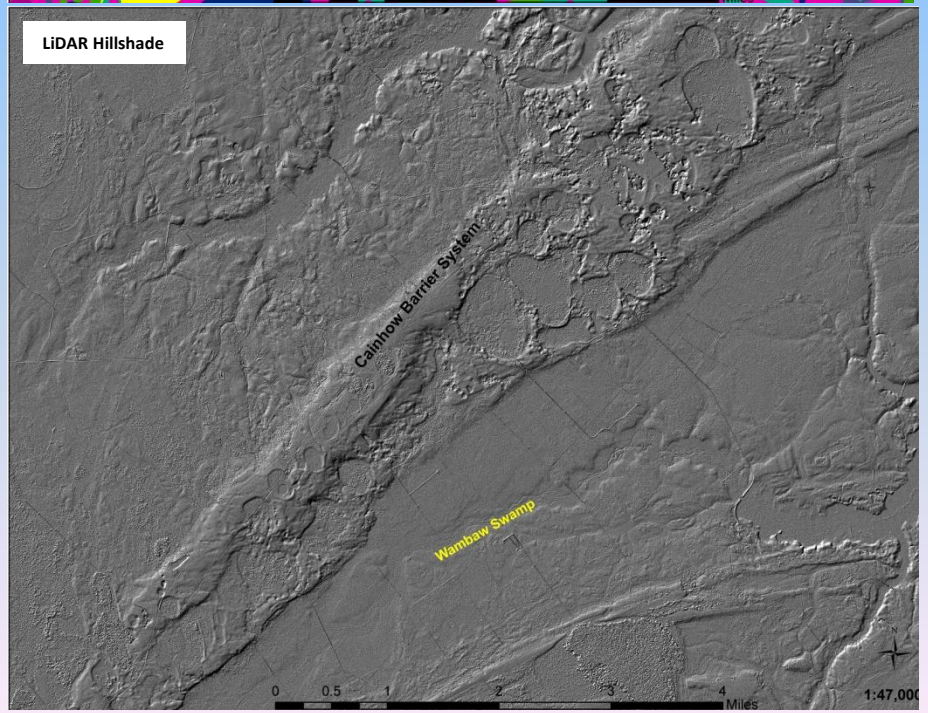
Atlantic Coastal Plain Streamhead Seepage Swamp, Pocosin and Baygall

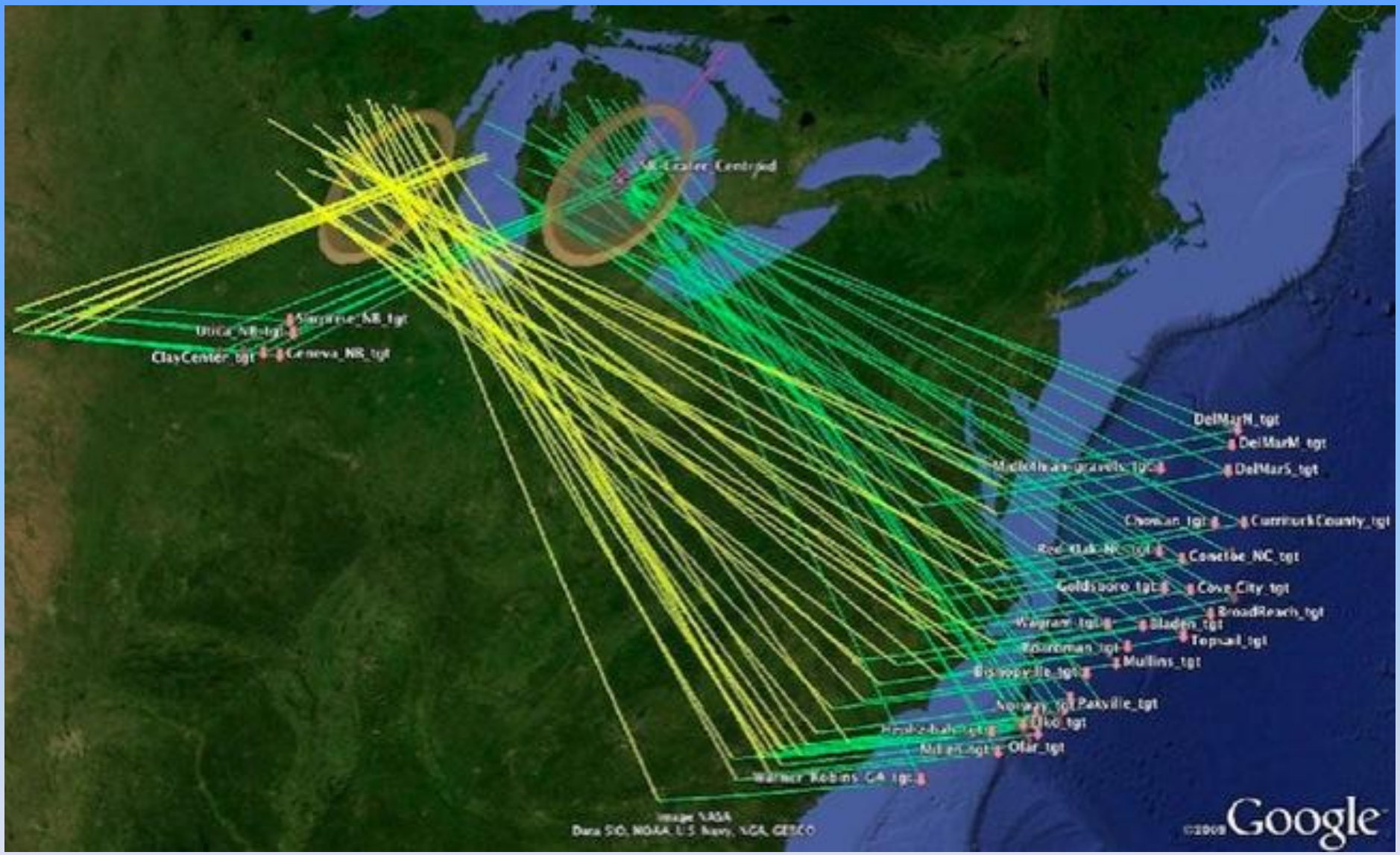
Wet Pine Savanna and Flatwoods, Hwy 45, Newland



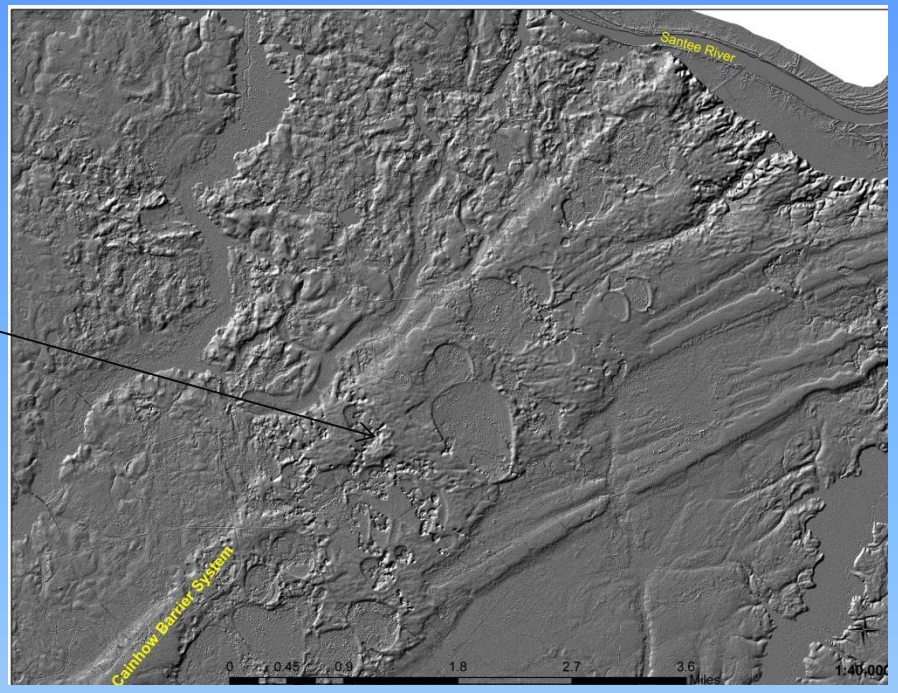
Carolina Bay Cypress Savanna Wetlands

Formed by the combined actions of prevailing southwesterly winds under conditions of fluctuating ground-water levels (other theories)



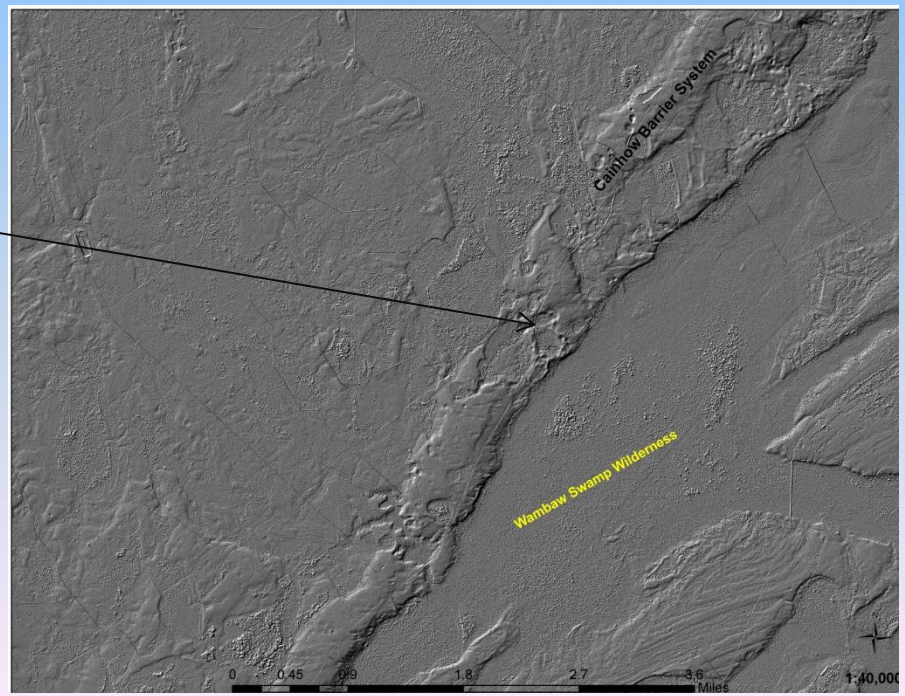


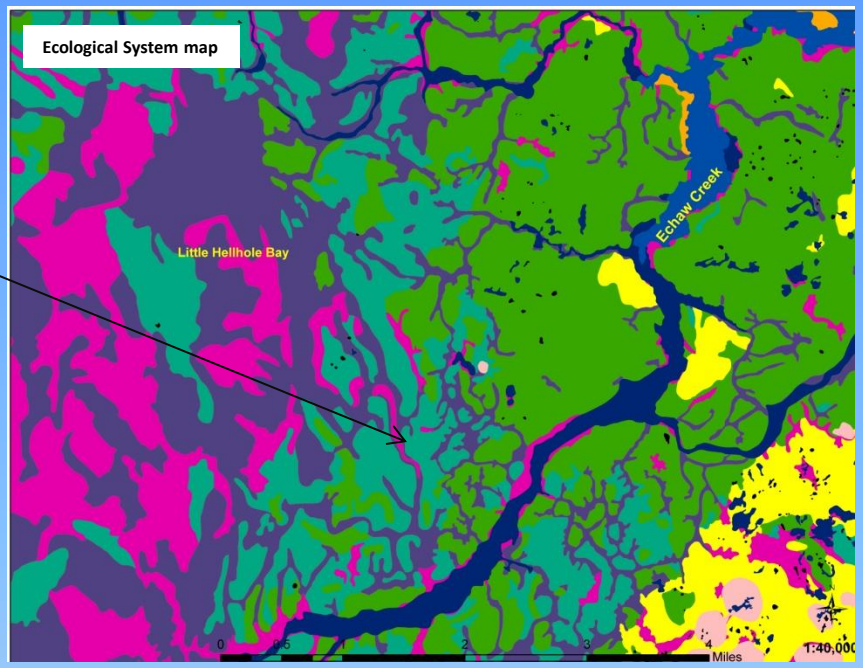
Cintos researcher Michael Davias proposes that bay formations are the remnants of an ancient cosmic collision with the Wisconsian ice sheet. He hypothesizes that the impact ejected ice and superheayed sediments outward in a butterfly pattern creating the shallow basins commonly known as Carolina bay Formations



Depression Ponds

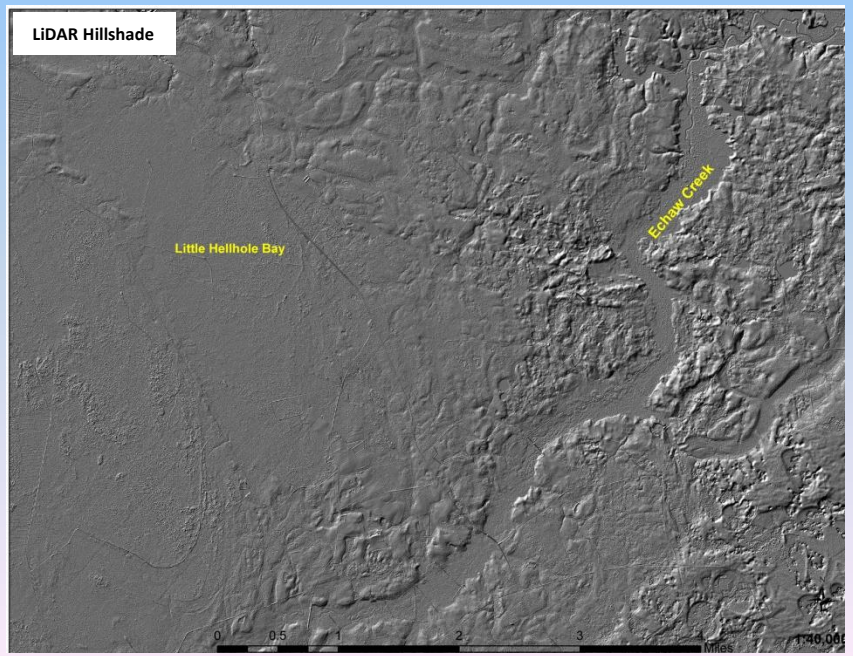
Formed by subsidence of surface sediments caused by solution in underlying limestone. Others may be formed as swales in mainland eolian sands, natural blockage of small drainages by sediment movement, and more obscure causes.





Wet Pine Savanna and Flatwoods

Found primarily on Marine Terraces in somewhat poorly to poorly drained soils.



Summary of Ecological System acreage within the FM proclamation boundary Ecological System	Acreage (rounded)	# map units Unique types
Wet Pine Savanna and Flatwoods (total acres)	138,320	
Wet Pine Savanna and Flatwoods (mesic_wet phase)	92,750	
Wet Pine Savanna and Flatwoods (wet phase)	45,570	
Nonriverine Swamp and Wet Hardwood Forest	113,790	
Upland Longleaf Pine Woodland (total acres)	106,130	
Upland Longleaf Pine Woodland –(xeric_dry phase)	15,540	
Upland Longleaf Pine Woodland –(dry_dry-mesic phase)	20,630	
Upland Longleaf Pine Woodland –(dry-mesic_mesic phase)	69,960	
Blackwater Stream Floodplain & Blackwater River Floodplain	19,090	
Large River Floodplain	8,680	
Tidal Wooded Swamp	7,860	
Salt and Brackish Tidal Marsh	6,660	50
Carolina Bay Cypress Savanna Wetlands	4,510	83
Nonriverine Basin Swamp	2,745	
Depression Ponds	2,095	435
Peatland Pocosin and Canebrake	2,030	15
‘Water’	1,650	
Dry and Dry-Mesic Oak Forest	1,110	56
‘Altered Land’	550	
Maritime Forest	476	82
“Depression Pondshore small sinks”	330	923
“Pocosin in Carolina Bay”	270	3
Mesic Slope Forest	225	21
Streamhead Seepage Swamp, Pocosin and Baygall	75	19
Fresh and Oligohaline Tidal Marsh	0	
total	416,600	

Photo: Francis Marion website

What are Ecological Systems Models?

Ecological Systems Models = probability predictions determined from a set of environmental data for a set of grid cells in a landscape, together with a set of sample locations where the Ecological Systems have been observed.

An Ecological System model expresses the suitability of each grid cell as a function of the environmental variables at that grid cell. A high value of the function at a particular grid cell indicates that this location is predicted to have suitable conditions for that Ecological System. A model is made for each Ecological System, models are combined, the highest probability type is assigned to each grid cell, and they are aggregated to map:

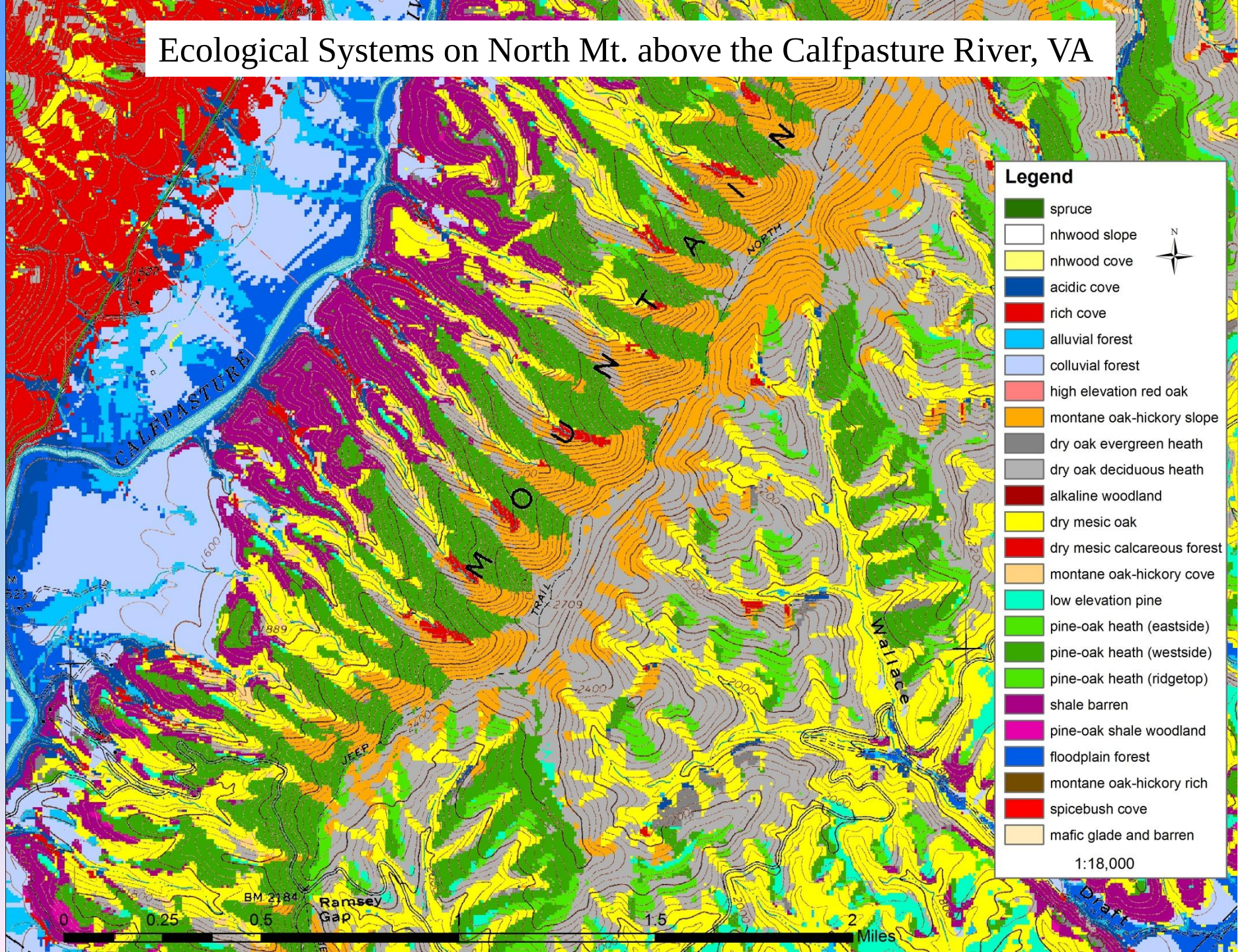
Units of land delineating the environment that can support a specific plant community or plant community group under historical disturbance regimes; they may or may not represent current vegetation (Ecological Zones).

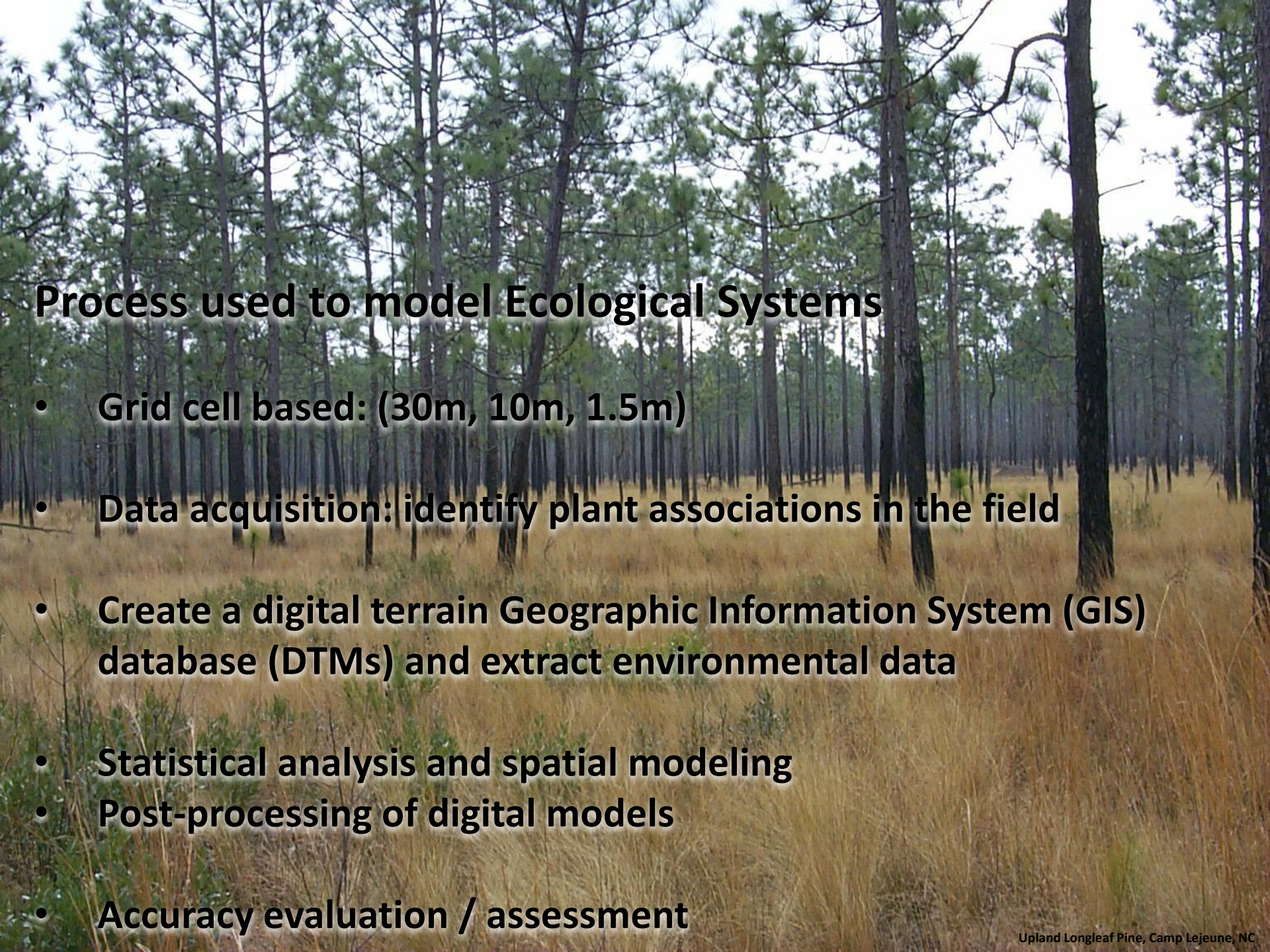
The vegetation that may have been dominant on the landscape prior to Euro-American settlement based on both the current biophysical environment and an approximation of the historical disturbance regime (Biophysical Settings).

Ecological Systems: Landscape perspective

Jefferson NF, VA: Steve Croy

Ecological Systems on North Mt. above the Calfpasture River, VA



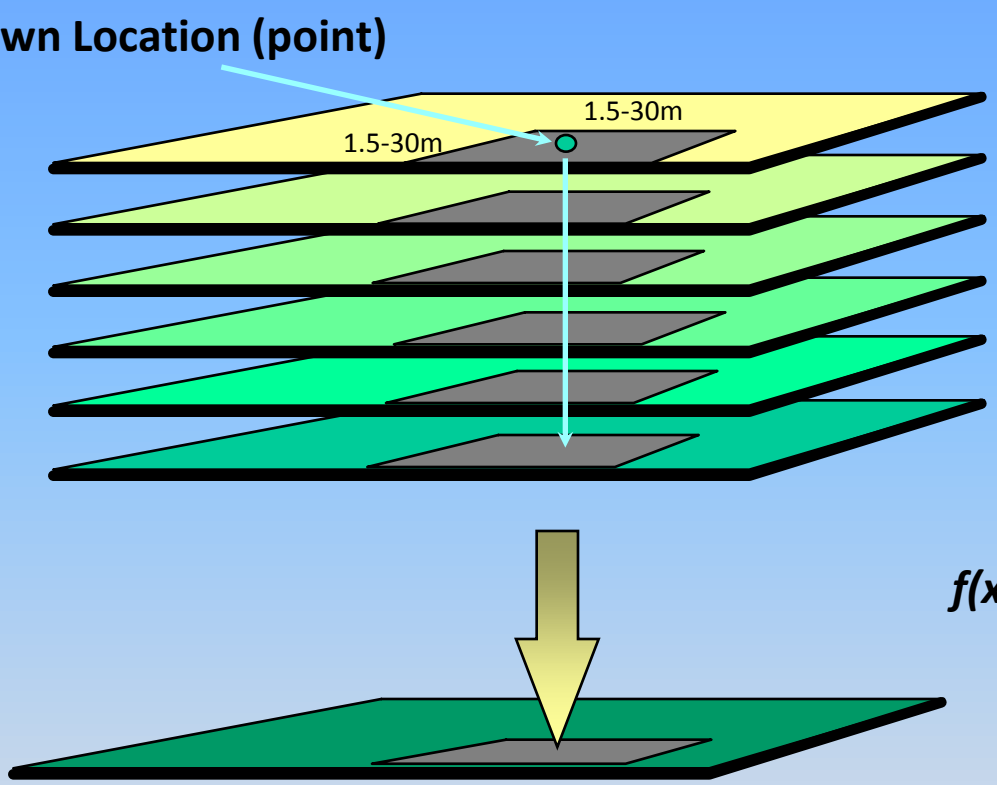


Process used to model Ecological Systems

- Grid cell based: (30m, 10m, 1.5m)
- Data acquisition: identify plant associations in the field
- Create a digital terrain Geographic Information System (GIS) database (DTMs) and extract environmental data
- Statistical analysis and spatial modeling
- Post-processing of digital models
- Accuracy evaluation / assessment

Upland Longleaf Pine, Camp Lejeune, NC

Ecological Systems modeling



Spatial Data Layers (DTMs)

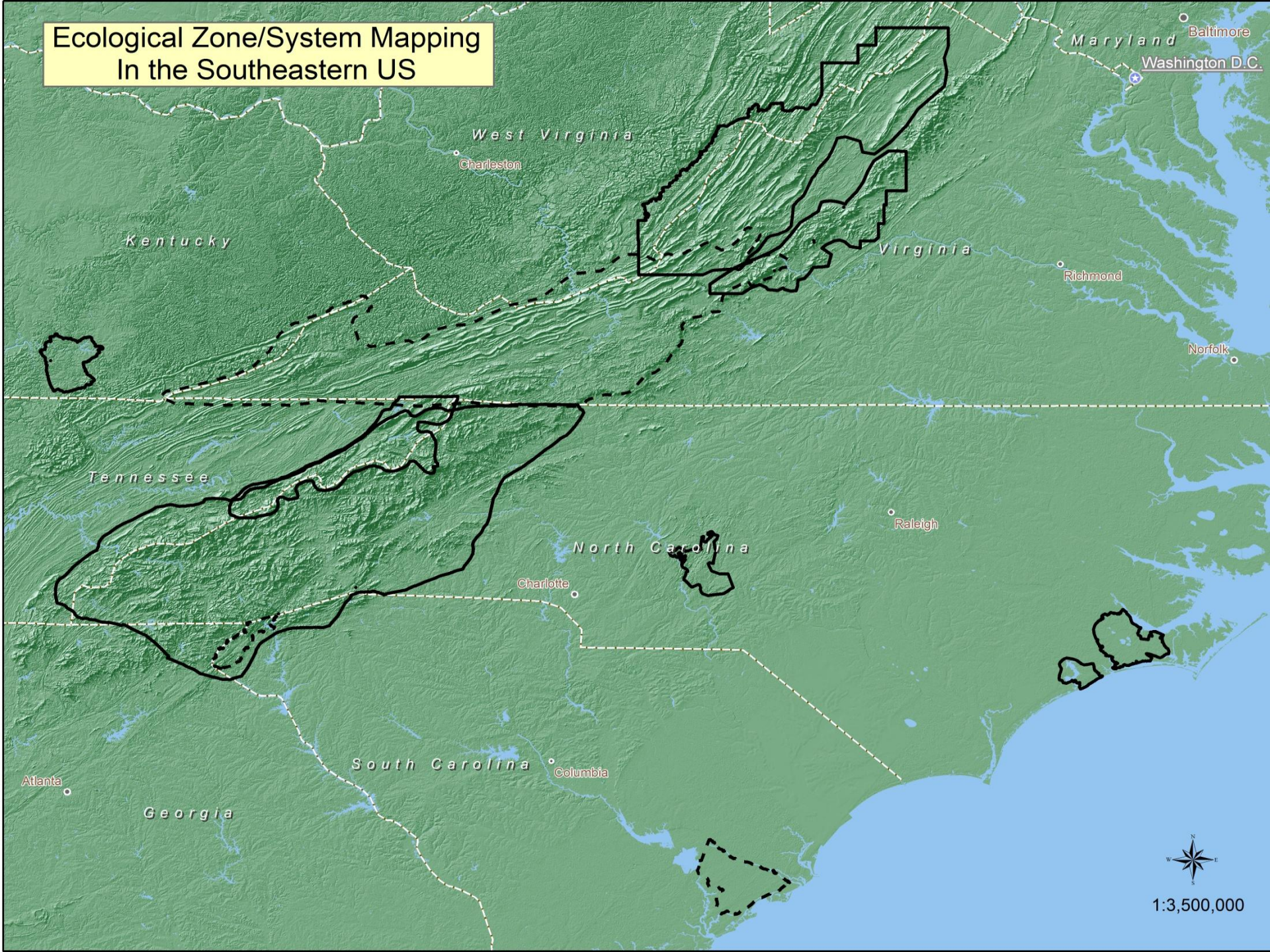
Elevation
Aspect
Slope
LFI (landform index McNab)
Distance from stream
Distance above stream
Relative slope position
Geology (+ 22 others)

f(x) → statistical function*

= Predicted distribution map from 1000+ points

•e.g. Maximum entropy, Logistic regression, Discriminant analysis

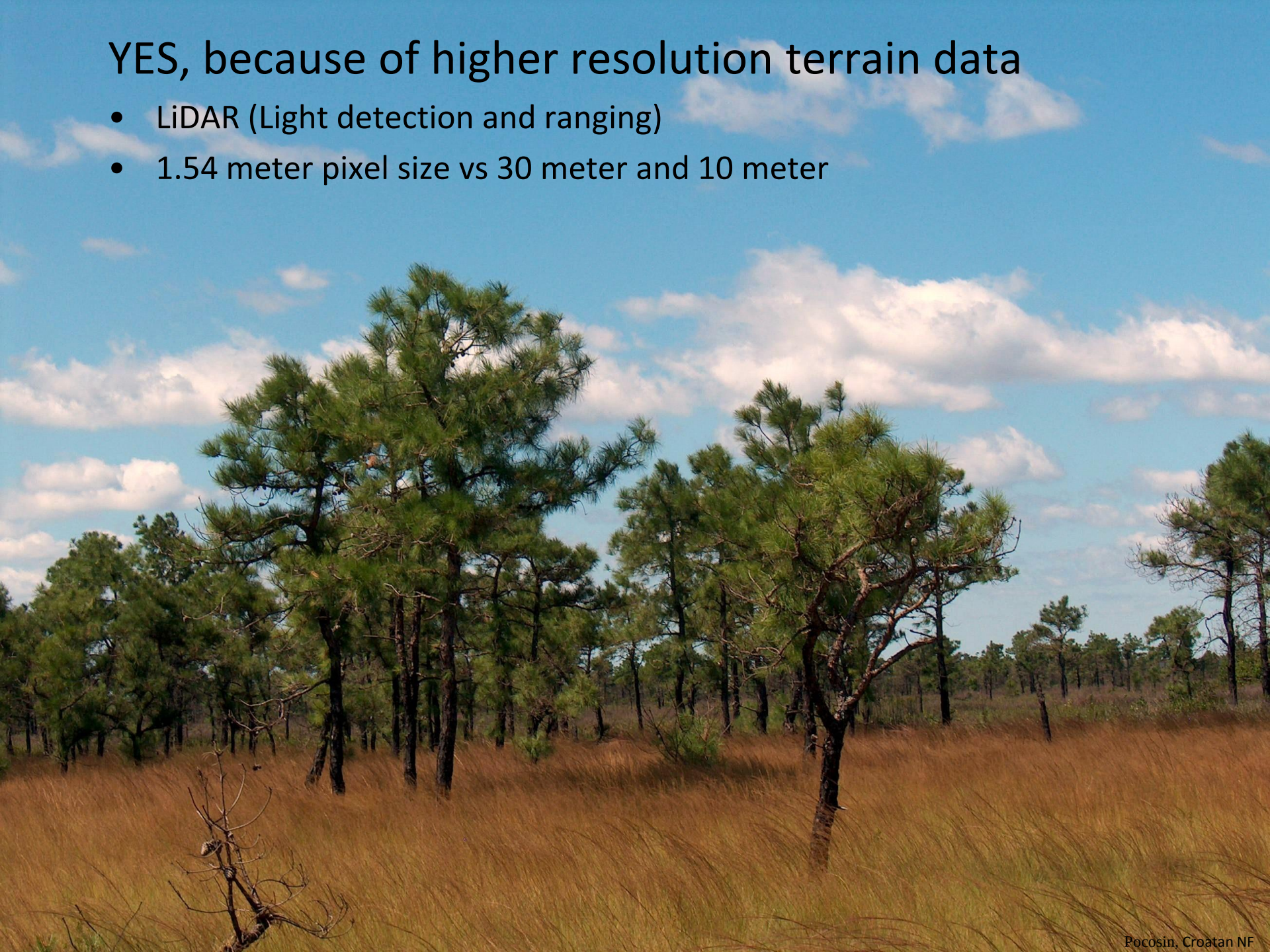
Graphic from "Assessment and Mapping of Vegetation Communities in the Shenandoah National Park," John Young, USGS


Ecological Zone/System Mapping
In the Southeastern US
West Virginia
Charleston
Kentucky
Virginia
Richmond
Maryland
Baltimore
Washington D.C.
Norfolk
Tennessee
North Carolina
Raleigh
Charlotte
South Carolina
Columbia
Atlanta
Georgia
1:3,500,000


Croatan NF
Can we model Ecological Systems on the Francis Marion NF?

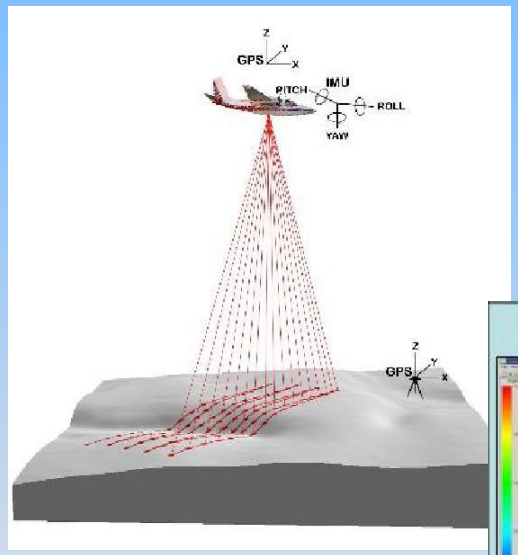
YES, because of higher resolution terrain data

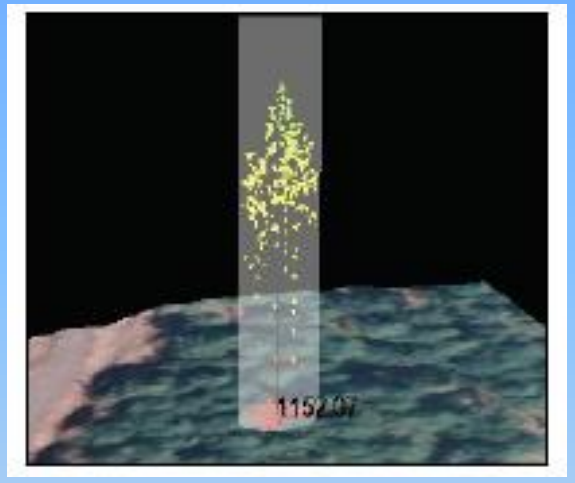
- LiDAR (Light detection and ranging)
- 1.54 meter pixel size vs 30 meter and 10 meter

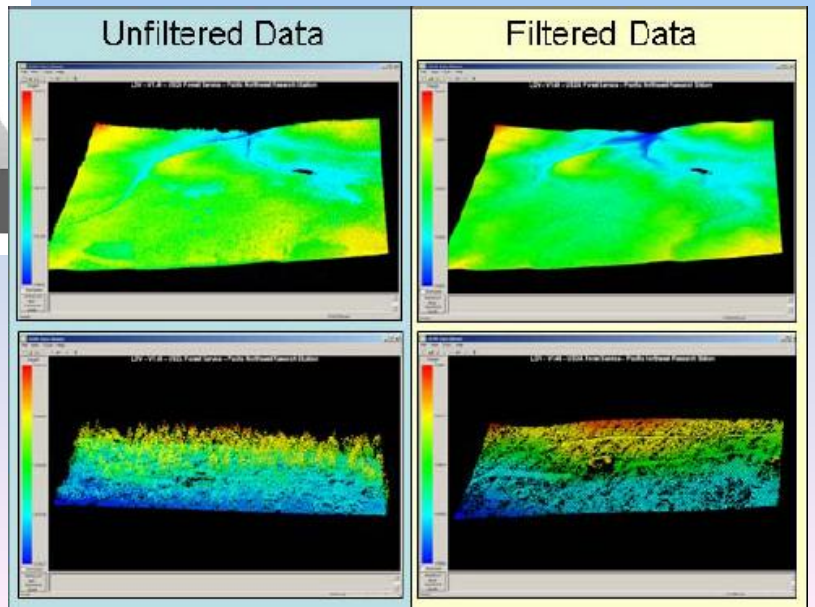


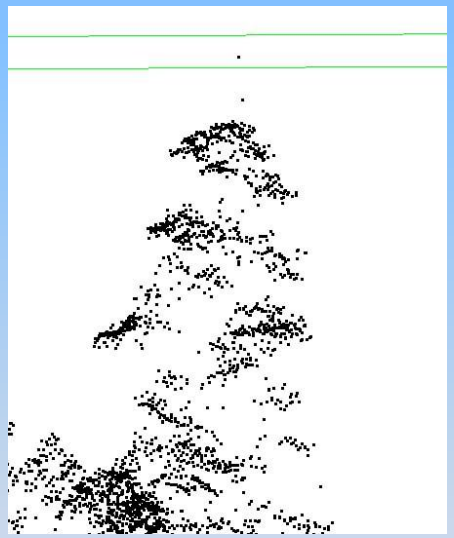
Pocosin, Croatan NF

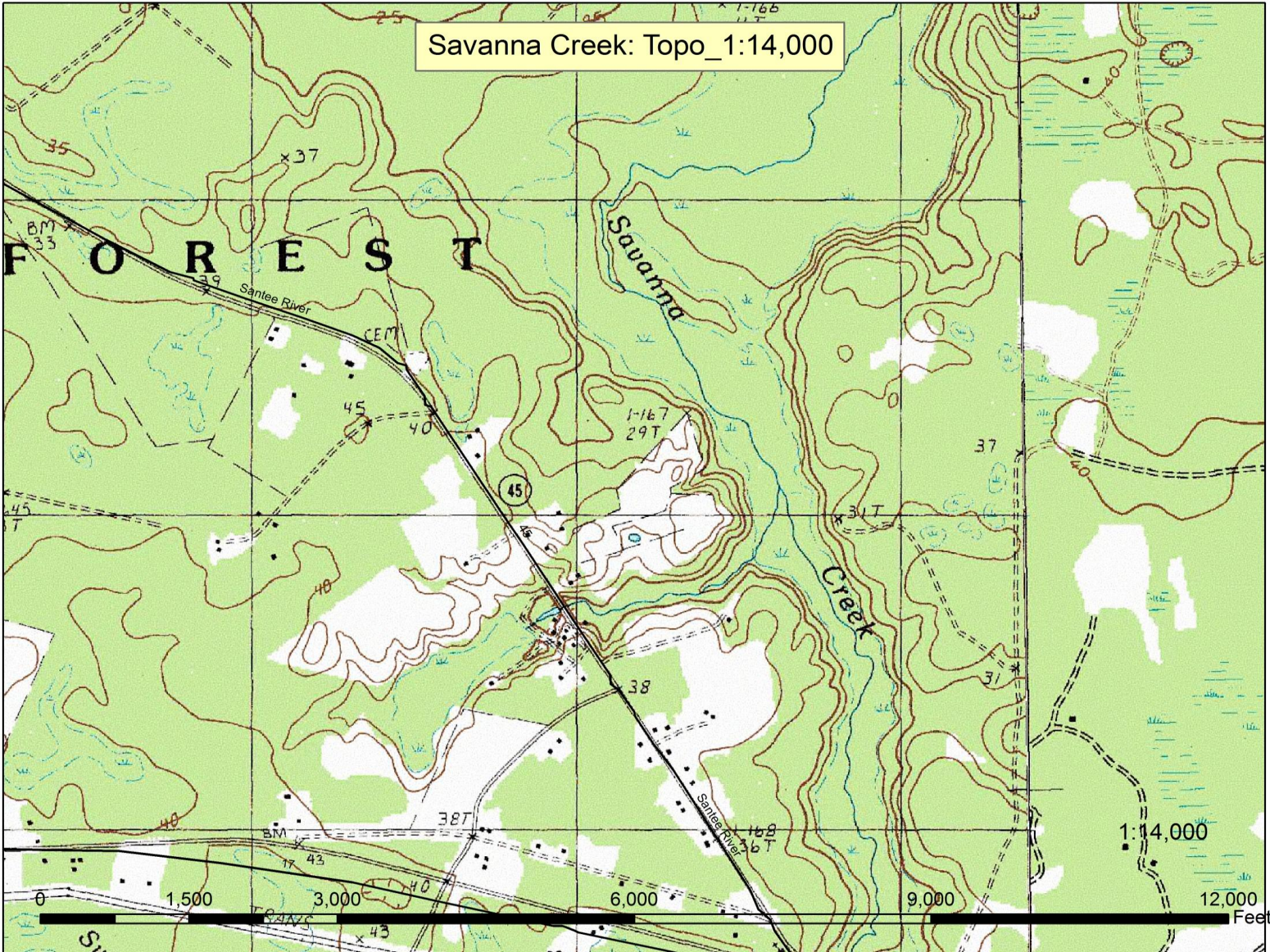
What is LiDAR?

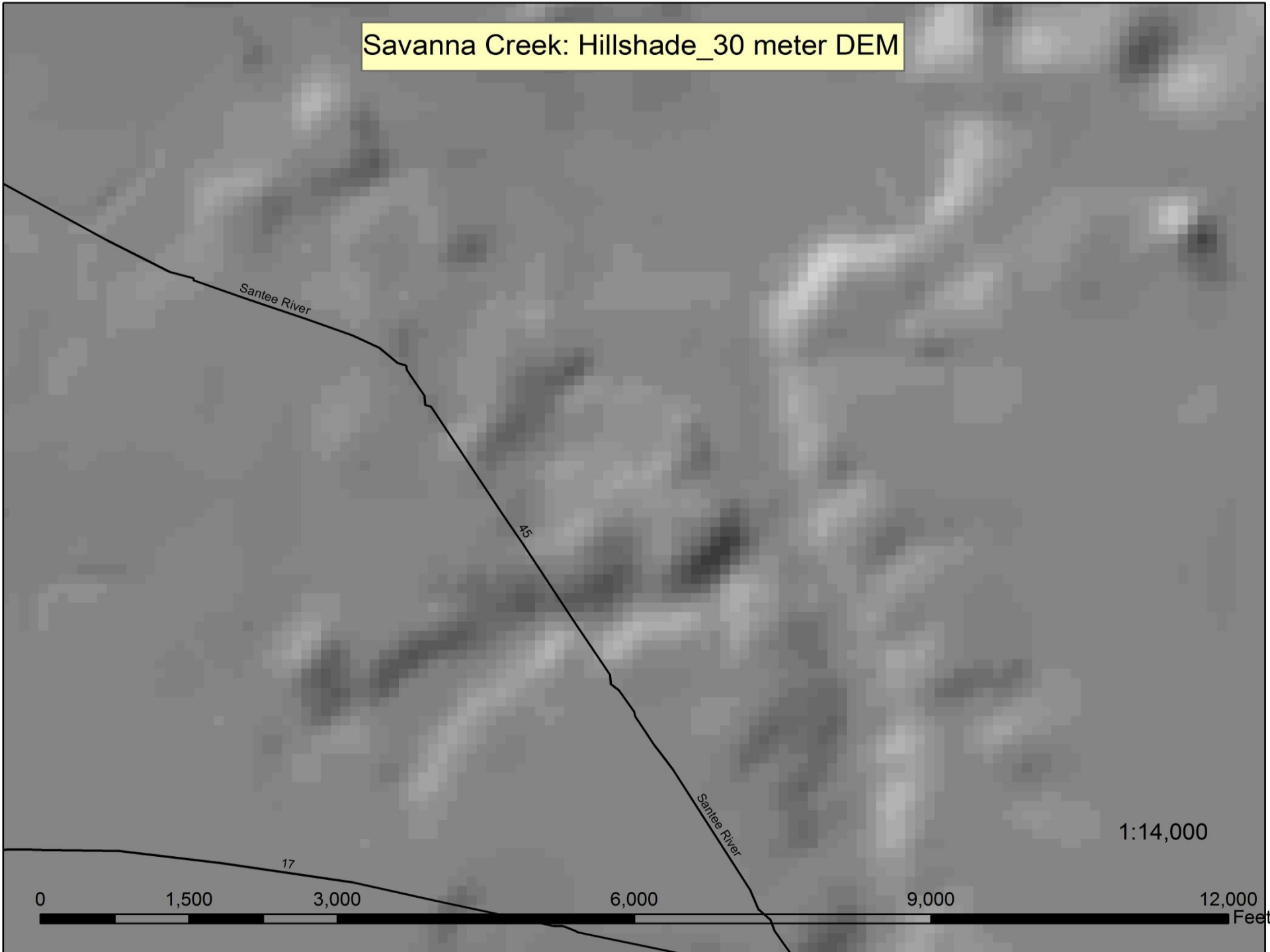


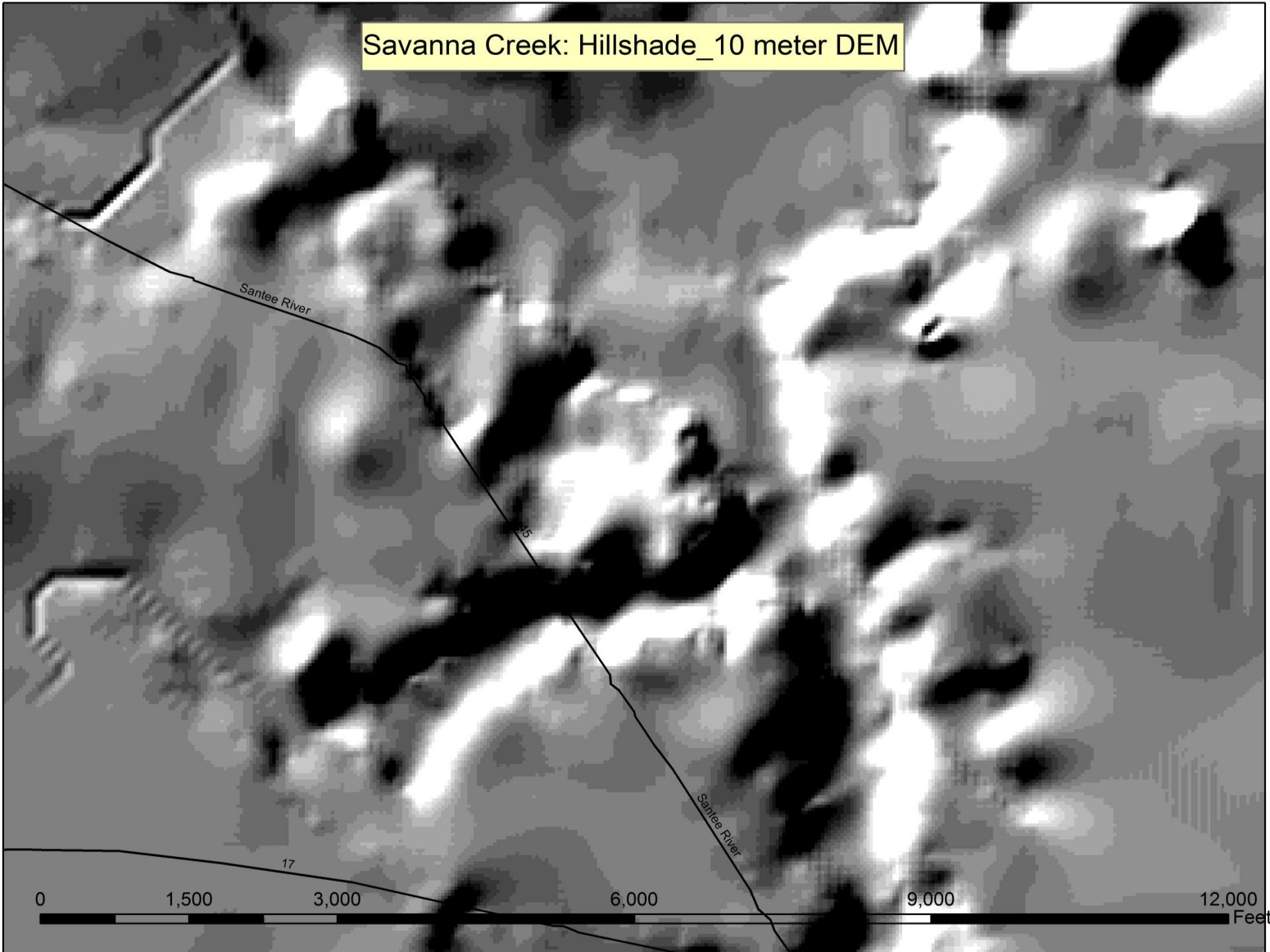


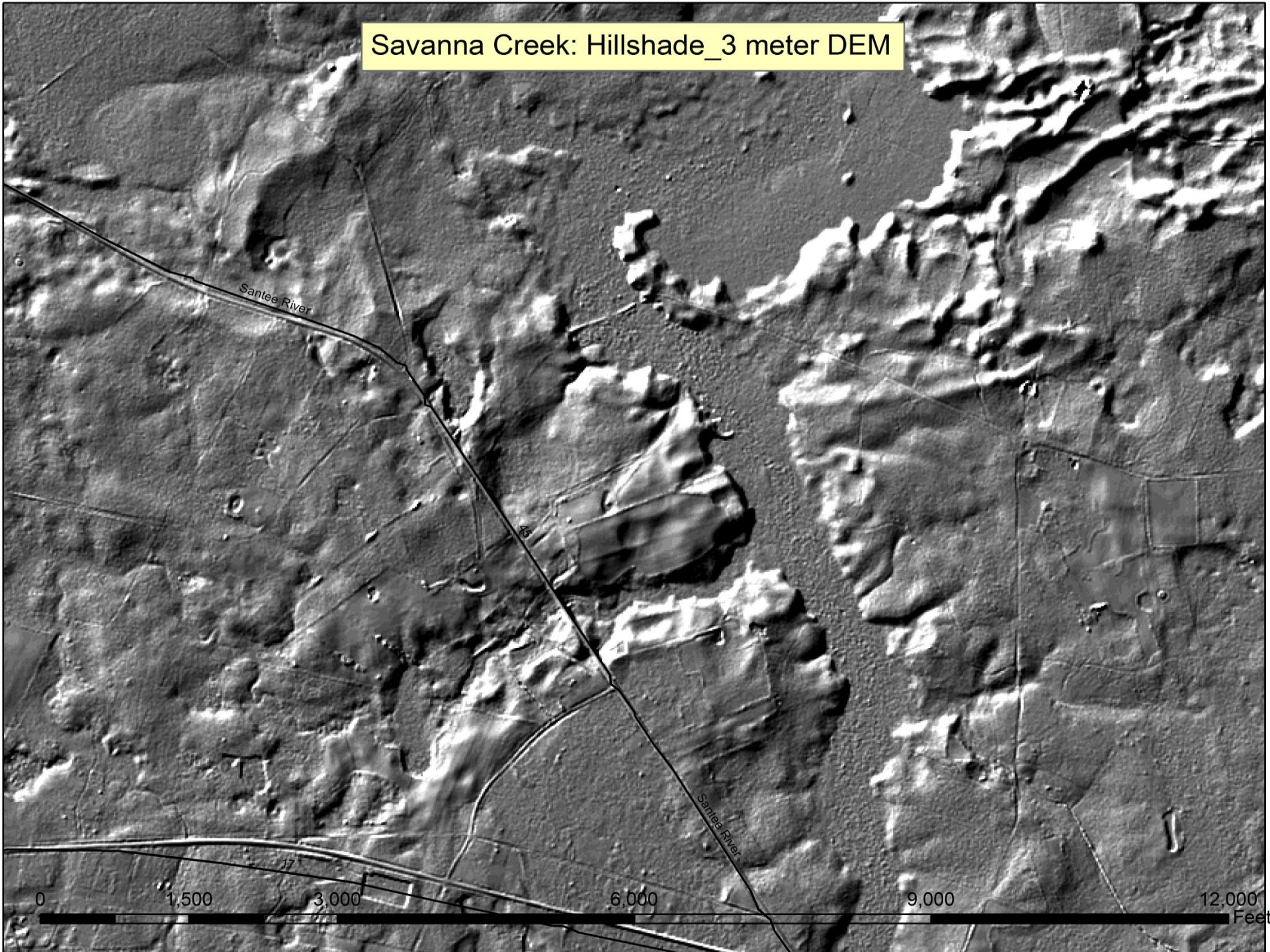





Savanna Creek: Topo_1:14,000
FOREST
Santee River
Savanna
Creek
Santee River
CEM
BM
TRANS
1:14,000
0
1,500
3,000
6,000
9,000
12,000
Feet


Savanna Creek: Hillshade_30 meter DEM
Santee River
45
Santee River
17
1:14,000
0
1,500
3,000
6,000
9,000
12,000
Feet

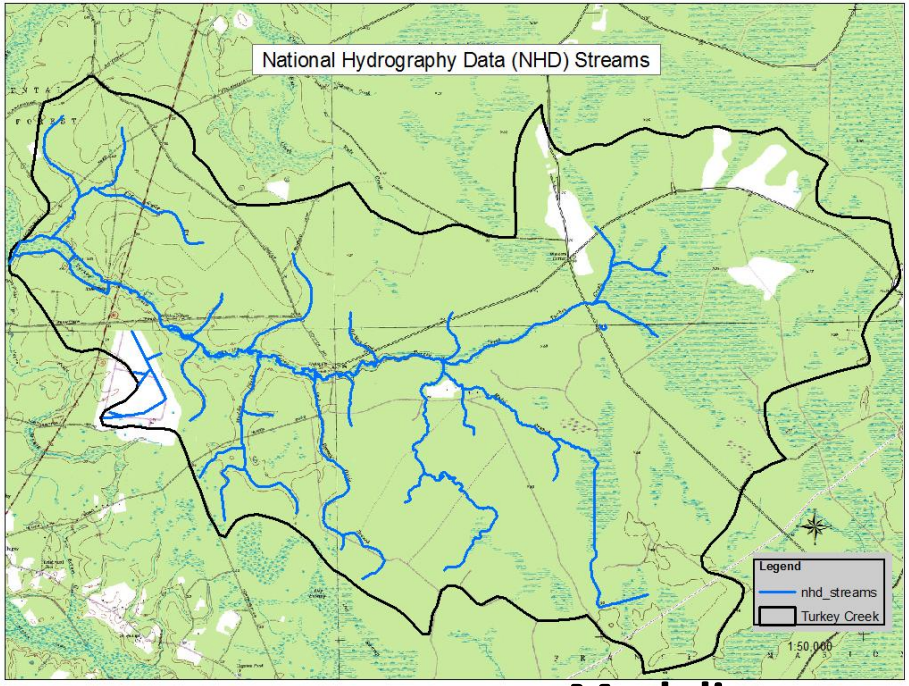

Savanna Creek: Hillshade_10 meter DEM
Santee River
15
Santee River
17
0
1,500
3,000
6,000
9,000
12,000
Feet

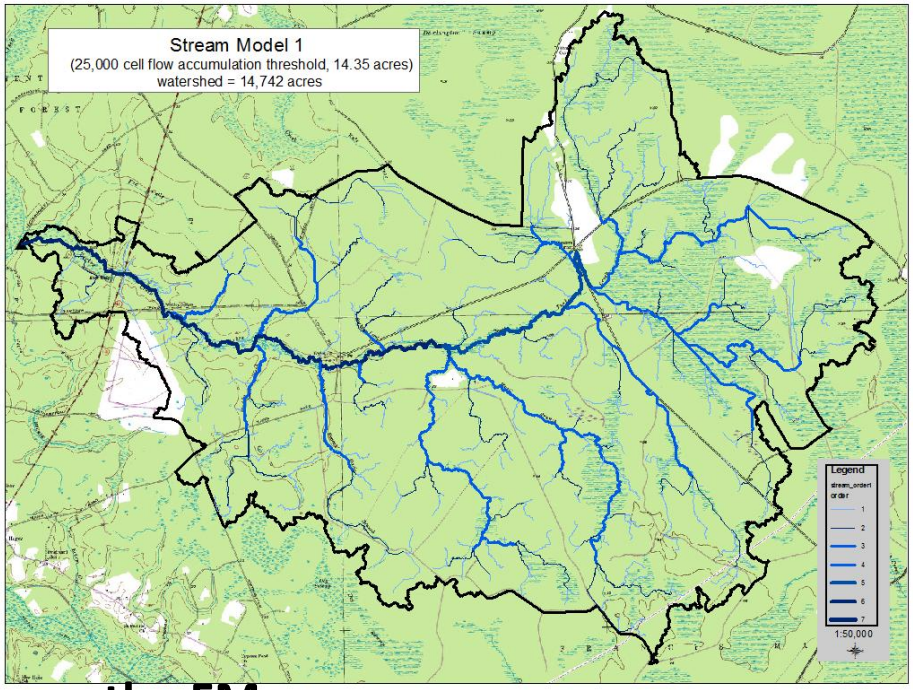

Savanna Creek: Hillshade_3 meter DEM
Santee River
Santee River
17
0
1,500
3,000
6,000
9,000
12,000
Feet

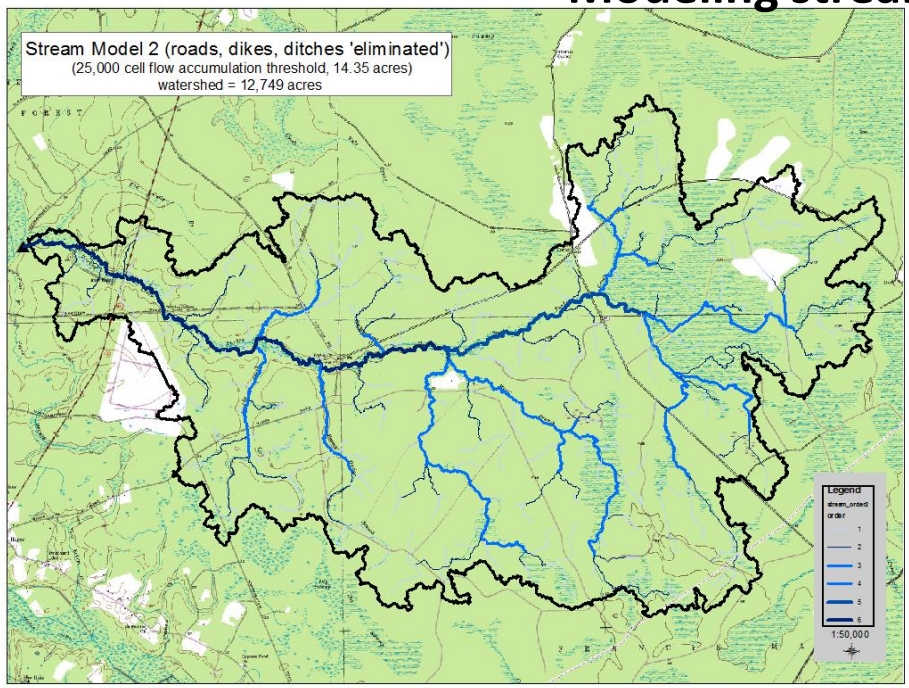
Environmental variables evaluated in Ecological Systems models

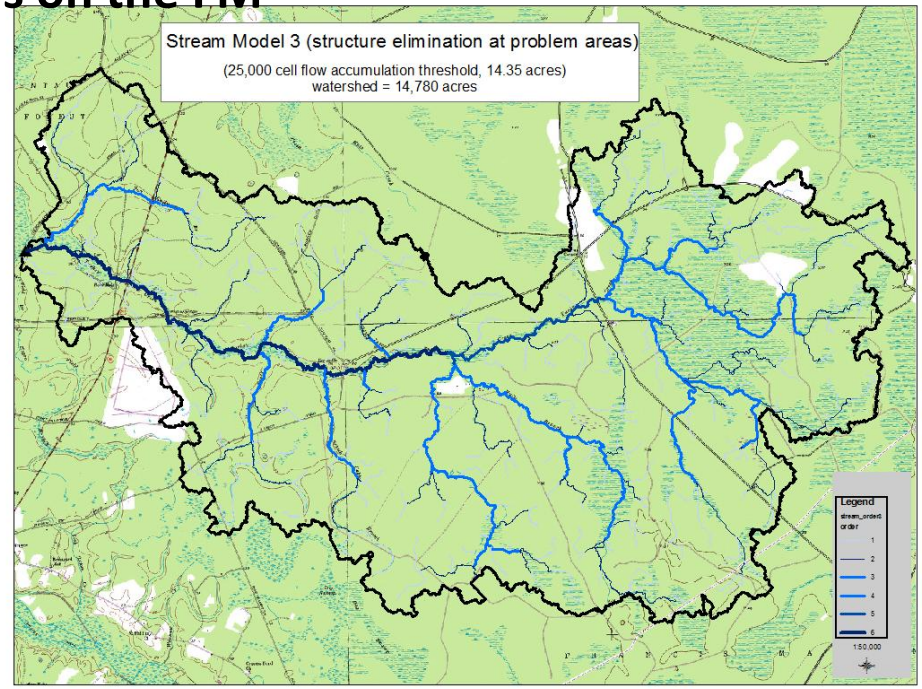
- Elevation
- Aspect (raw & transformed)
- Slope
- Curvature of land
  - all directions
  - direction of slope
  - perpendicular to slope
- Landform index (McNab)
- Terrain shape index (McNab)
- Relative slope position (fine scale)
- Basin slope position
- Terrain relative moisture index
  - fine scale
  - medium scale
- Stream influence (modeled)
  - distance to streams
  - elevation above streams
- River influence (4^{th} + order)
  - distance to rivers
  - elevation above rivers
- Tidal extent (3 yr. max tide)
- Maritime influence
  - distance to Atlantic Ocean
- Solar radiation (yearly)
- Precipitation (30-year average)
  - yearly
  - growing season
- Geology
  - distance to limestone
  - distance to peat
- Soil
  - distance to histosols
- Fire compartment size
- Tar kiln density

Modeling streams on the FM

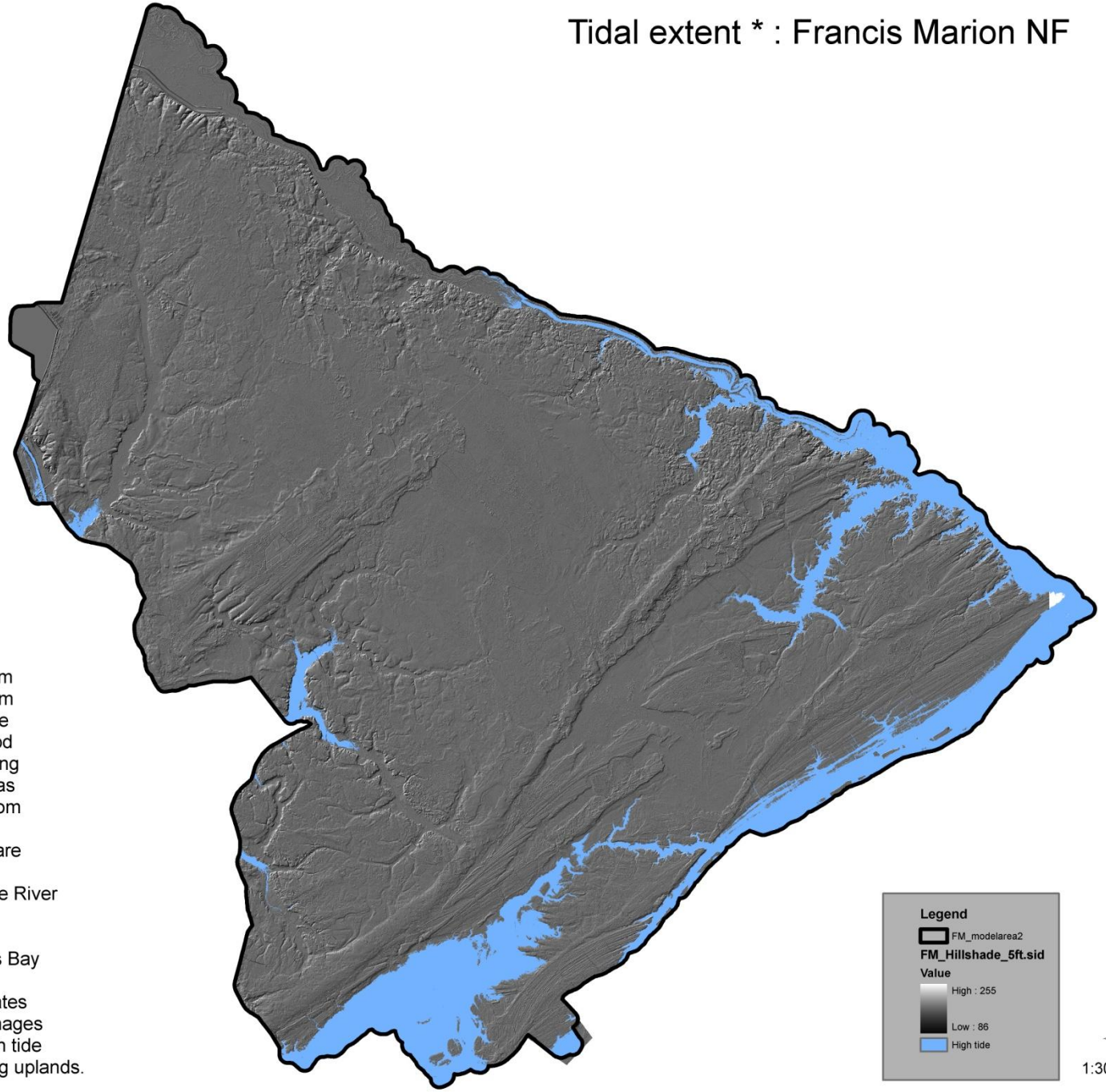








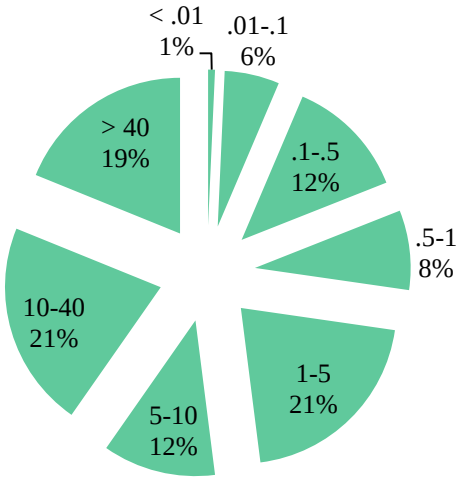
Tidal extent * : Francis Marion NF



* Tidal extent is derived from the average of the maximum monthly, predicted high tide levels during a 3-year period starting from 2010 and ending in 2012. Tidal influence was determined at 4 locations from the following tide level measurement stations that are at or near sealevel:
US Highway 17 Bridge S. Santee River
Quinby Creek bridge
Wando River at Cainhoy
Harbor River Entrance in Bulls Bay

Note: this display overestimates the tidal extent outside of drainages because it merely extends high tide elevation to all landscapes, including uplands.

Fire Compartments* on the Francis Marion NF



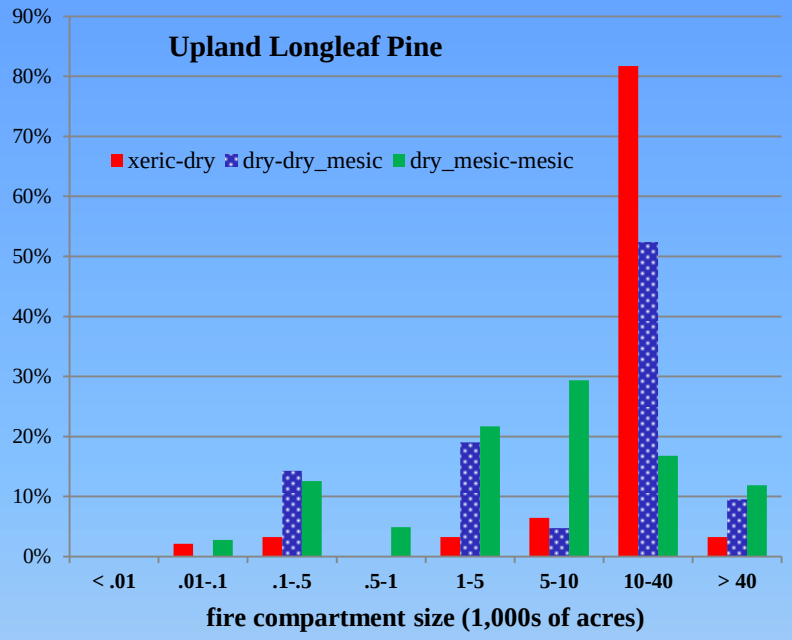
proportion of fire compartment landscape, 1000s acres

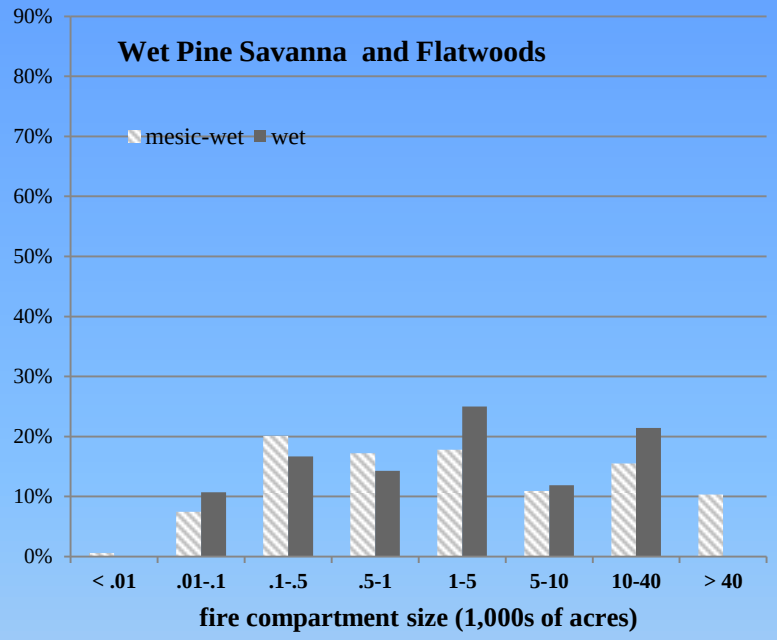
1:300,000

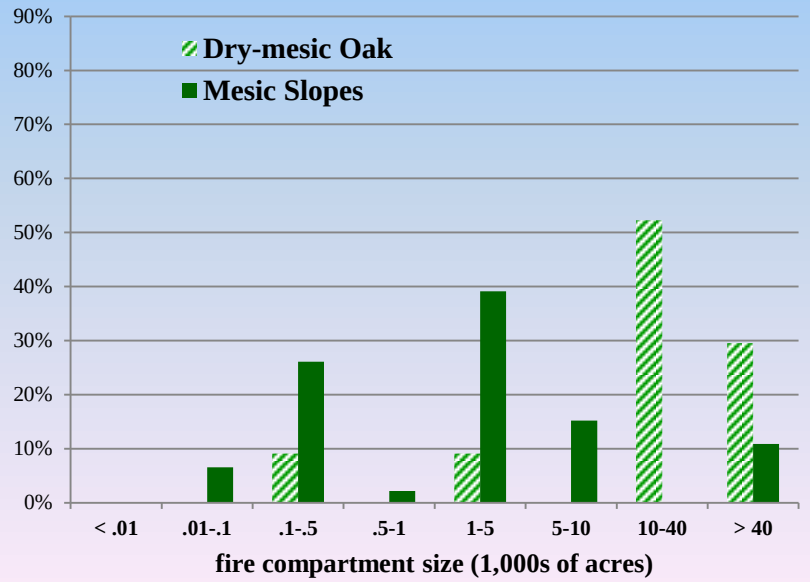
* Fire compartments are defined as “A unit of the landscape with no natural firebreaks, such that a lightning ignition (or planned ignition) in one part would be likely to burn the whole unit unless there was a change in weather or fuel conditions (Frost 1995).

* fire compartments are shaded green barriers to fire movement are white

Fire Compartment size: Upland Longleaf Pine, Wet Pine Savanna and Flatwoods, Dry-mesic Oak, and Mesic Slopes







Summary

- Past climates/geomorphic processes have shaped the current and potential Ecological Systems on the FM
- Past and current land management practices have altered Ecological Systems current and potential extent
- The 1st Approximation map of FM Ecological Systems reflects the diversity of Ecological Systems on the FM
- A method for modeling Ecological Systems in the mountainous areas of the SE US has proven to be useful
- Environmental modeling will provide a more accurate map of Ecological Systems potential on the FM

Salt and Brackish Tidal Marsh with Maritime Forest fringe, Guerin Creek

- QUESTIONS?

1:286,000

Ecological Systems on the Francis Marion NF